PRCI Project Ref: MD-1-1

QUARTERLY REPORT – PUBLIC PAGE

Development of Dual Field MFL Inspection Technology to Detect Mechanical Damage

Date of Report: April 30, 2007

Contract No: DTPH56-06-000016

Prepared For: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

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For Period Ending: April 30, 2007

Milestone and Deliverable Accomplishments this Reporting Period

Task No.	Task	Scheduled Completion Date	Completed Date	Milestone
A-2.2	Build Tool – Magnetize Design	31 Oct 06	30 Apr 07	MS
A-2.3	Build Tool – Mechanical Design	31 Oct 06	30 Apr 07	MS
A-6.1	Reporting/Meetings	30 Apr 07	30 Apr 07	MS
A-7.1	Third Quarterly Report Submitted	30 Apr 07	30 Apr 07	MS

Technical Status

Mechanical Design:

The mechanical design has been completed. It consists of the high field unit at the front of the tool, downstream of the low field unit, with the caliper arm unit (XGP) at the rear of the tool. The caliper arm unit follows the low field unit and consists of two planes of caliper arms that are circumferentially offset in order to ensure 100% circumferential coverage. The tool has two guiding disks, which reduce tool vibration, and six sealing cups, which create a differential pressure in the pipe to propel the tool. In the liquid line the tool should travel at the liquid flow rate, at which speed it will take approximately 115 hours to complete the run of the liquid line. There will be just enough battery life to complete the run, as there are 120 hours of battery time available.

The overall tool length is 4980 mm, the rear sealing length, which is the distance between the rear edge of the tool and the first sealing cup (the first cup on the second magnet unit), is 2937 mm, and the launch length is 4674 mm. According to the launcher and receiver information provided the tool meets the required dimensions. The tool can pass through up to 1.5D bends, although the minimum bend on the pipeline is 7D according to the provided specifications

Magnetizer Design:

The magnetic design was carried out using a magnetic finite element modeling package and has been completed. It is a four pole design consisting of separate low field and high field units, with the high field unit downstream of the low field unit (the high field unit comes first). The high field unit will be downstream of the low level unit to be able to accurately induce the desired low level magnetization, additionally this will ensure that the magnetization induced by the low field unit is reproducible in case of the need for a rerun, and for multiple pull tests. The magnetizer is designed to prevent the magnetic field created by each of the high and low field units from leaking to the other unit. To prevent this, the poles are arranged so that the polarity of the low field pole is the same as the polarity of the neighboring high field pole.

The high field unit is designed to achieve a field strength within the range of that used by standard ROSEN tools, so its design presented a more standard challenge than that of the low field unit. It has been found that the optimum method to achieve the specified low field magnetic strength over the existing wall thickness range is to reduce the effective strength of the low field magnet packages by removing some of the magnets from the magnet packages.

At lower magnetic field strengths there is a greater variance in the resulting magnetization for different pipe wall materials than at higher field strengths where saturation is approached. Therefore in order to minimize the error it is necessary to obtain sample pipe wall material from Enbridge in order to accurately determine the B-H curve.

Scaling Function and Tool Rotation Algorithm Development:

Work on the scaling function algorithm has begun and the algorithm developed by Battelle has been analyzed. The scaling function will scale down the high-magnetization-level signal so that it can then be subtracted from the low magnetization level signal. According to the documentation provided by Battelle the scaling function requires the peak amplitude of a feature, measured above the baseline, at both magnetization levels, along with the high and low magnetization levels themselves and a set of parameters. The parameter set for the scaling function has been derived from laboratory experiments, which confirms the results given by Battelle, but is inadequate for any real application due to large data scatter. A scaling function parameter set based on finite element calculations is necessary. To create the parameter set the peak amplitudes from the finite element calculations have been requested from Battelle along with Excel graphs of the parameters based on the finite element calculations. Once the parameter set is known the scaling function can be directly implemented into a data preparation program.

Tool rotation may be a consideration when correlating the results of the two different magnet circuits to calculate the decoupled signal, although the combination of two magnet units may reduce the tool rotation,. However a simple correction method, which should not add any error, is being developed to deal with tool rotation.

The correction algorithm for the tool rotation will consider the circumferential sensor spacing and the orientation of the tool in the pipeline (the tool top position). If the top position of the high and low level circuits, at a given log-distance, differs by more than half of a sensor separation to either side, the corresponding sensors of the leading circuit will be associated with the next sensor in the direction of rotation of the trailing circuit. By applying this one-to-one association of the sensors from both magnet circuits time-consuming data interpolation is avoided.

Schedule

Technical progress remains slightly behind schedule.

Plans for Future Activity

Discussions concerning the need for a section of pipeline for a pull test have been held with Enbridge. The specifications of the pipeline section, along delivery plan need to be further elaborated.